

VALERI – 2001 Field campaign in Counami (French Guiana)



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The VALERI-2001 field campaign carried out in the tropical rain forest in French Guiana, took place in the middle of the dry season (July-November). This period is optimal to acquire simultaneously high resolution SPOT images and field data. This is also the only period where the forest is accessible in reasonable conditions. The main goal was to measure leaf area index to describe the spatial heterogeneity of this complex ecosystem. The mission was possible with the co-ordination of three institutions (CIRAD, INRA and IRD). The choice of the Counami forest was driven by its accessibility by a stone-way and the possibility to lodge there in a hut for several days during the experimentation. Counami forest is also a study area for ecologists from different institutions in French Guiana.

Site description

The Counami forest is located in the Northern part of the Amazon forest on the North - Eastern slope of the Guiana's plateau in French Guiana (Figure 1). The geographic location is 5°21' North and 53°15' East. Situated 50 km away from the Ocean, the landscape is an evergreen tropical forest with 2750 mm of rainfall per year and a mean annual temperature of 26°C. Diurnal variations do not exceeds 12°C and the hygrometry is between 80% during dry season and 90% during rainy season.

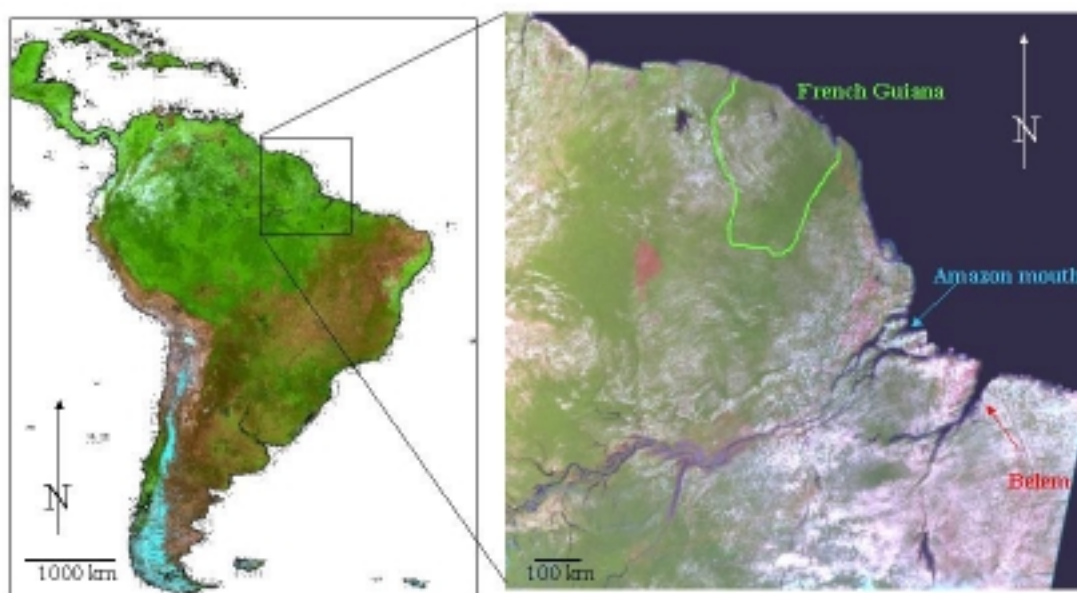


Figure 1 : Geographic context of South America on the left (SPOT-4 VEGETATION S10 data). On the right a zoom over the Northern Amazon basin with French Guiana (in green) (SPOT-4 VEGETATION S1 data).

Counami's landscape is a large flat plain resulting from a long period of erosion. The geology is mainly an old shale substratum (2.1 billion year) with granite intrusions. Geomorphology of the area is a consequence of the permanence of the warm and wet climate which induces a chemical weathering named ferralitization. Kaolinitic clay is the result of this weathering and can be very thick from 10 to 70m deep. The aspect of the landscape in these areas is a large plain covered by hemispheric hills (20 to 50m high) separated by a dense drainage network. It is the well known half-orange relief of the tropical regions. At the top of some hills it is possible to have iron-pans or gravels resulting from dryer paleo-climates which influence locally the soil distribution. In these conditions different soils were developed depending on

the slope and the altitude (Freycon, 2001). Considering the FAO-Unesco soils classification the soils present in Counami forest are classified as ferralsols (Driessen & Dudal, 1991). Water percolation in these soils is the main factor of the forest structure distribution (Sabatier, *et al.* 1997). From the top to the bottom of the hill, the impervious clay horizon goes closer to the soil surface and block water percolation and roots development (Paget, 1999; Clark & Clark, 2000). So, the structure of the forest depends on the topographic situation (plateau, slope or thalweg).

Characteristic of the tropical rain forest, the study site is composed by many different tree species, barely 150/ha (Nelson, *et al.* 1990 ; Whittaker, *et al.* 2001) . This richness is due to the low extinction rate due to the absence of glaciation and a high level of species diversity due to the alternation of dry and wet periods during the Quaternary (Molino & Sabatier, 2001). The main canopy is around 30m high with emergent trees at 40m high. The canopy is in general very dense with jointly crowns. Most of the trees have a diameter between 10 to 60cm. Some of them have a diameter of 1 or 2m (in general on the plateau). The paradox is that this forest is homogeneous in its heterogeneity. The understory is generally dense mostly in the thalweg where palm trees are abundant. A lot of lianas and epiphytes climb on the tall trees. The soil surface is covered by dead leaves (layer of 5 to 10 cm) which are quickly decomposed by micro-organisms. Seen from above the forest appears very compact. As shown with an aerial photography, it is difficult to identify differences between the forest types (Figure 2). The relief appears strongly with shades and sun faces but a delimitation between forest types is difficult, even for a photo-interpreter (Trichon, 2001). Several techniques try to resolve, at this scale, the ambiguities to determine stand structure in these non-perturbed by human activities forests.

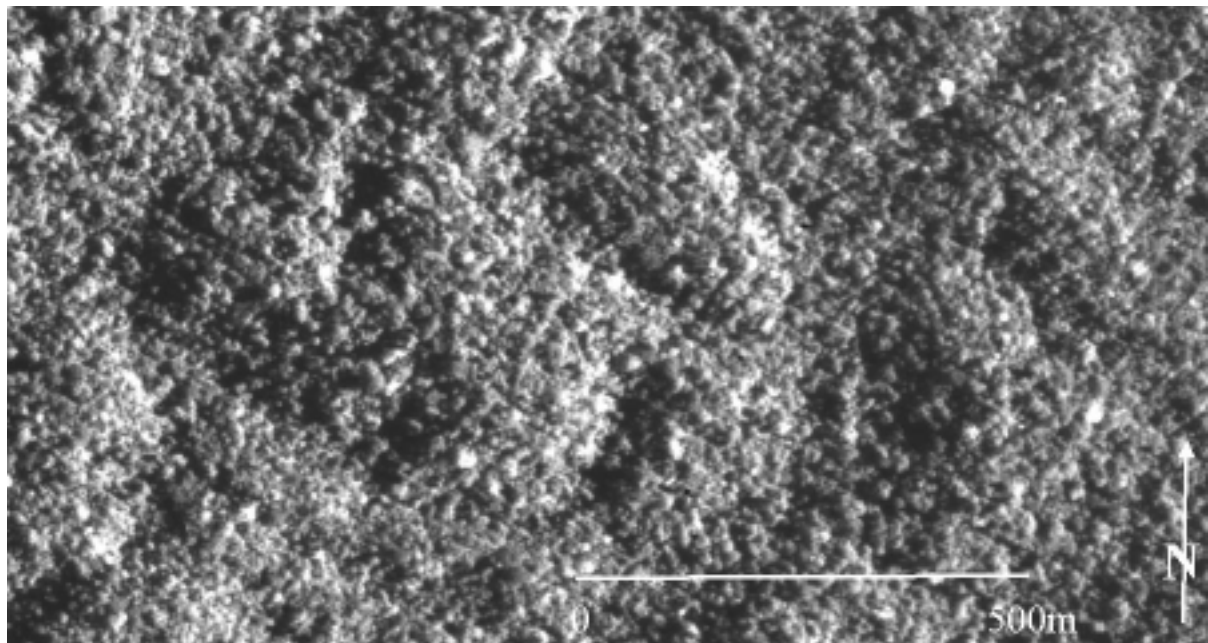


Figure 2: An aerial photography of the Counami forest (1981). The half-orange relief is covered by the tropical rain forest.

Material used

All measurements were made by two separated teams, from September 24 to September 27 between 10:00 (a.m.) and 17:00 (p.m.). The LAI measurements were made with two Nikon Coolpix 990 digital cameras using fish-eye lenses (360°). The cameras were installed on a 60cm high tripod to avoid perturbation from the user and to keep a standard position (50 cm above the ground level) of the sensors during the experiment. This was possible because of the scarcity of vegetation below 60cm.

The geographical position of the measurement sites were pre-established using a 1/50.000° topographic map. During the field measurements two GPS instruments (Garmin CX12 and Magellan C815) were used to catch geographic position in a WGS84 ellipsoid reference. A minimum of three satellites were used to get a maximum precision in the measures under the canopy. Otherwise an approximate position was written down on the topographic map.

An integrated photosynthetic active radiation (400 – 700 nm) sensor (BF2 instrument) was installed 30km East of the Counami forest, in a safer area for autonomous measurements (Paracou, 5°16'North – 52°57'West). This instrument was used to measure direct and diffuse sun radiation from September 18, to October 16. Installed in a flat position the instrument was supplied with a 12V battery.

A simultaneous remote sensing acquisition was planned with the SPOT-Images company (KJ 689-339). From September 1 to November 1, four quick-looks were delivered (September 7, September 12, October 18 and October 19). Because no clouds were identified over the study area for October 18 (day 291), this scene was acquired. Calibration and navigation were processed by the SPOT-Images company in Toulouse. According to landmark measurements using GPS in November 2001, the geo-location of the SPOT data was also processed in the referenced system WGS84.

A field-card was established to note quickly during the measurements different information about the environment of the measurement sites. These field-cards are numbered and described the situation (location, type, slope, exposition, hydrology), soil (aspect, structure), canopy and understory (diameter, height, liana, damages).

Method employed

The method employed during this study was driven by the idea of taking into account the spatial heterogeneity in the continuum of the forest canopy. The spatial integration of LAI measurements related with remote sensing data, developed in the VALERI program, was a permanent preoccupation.

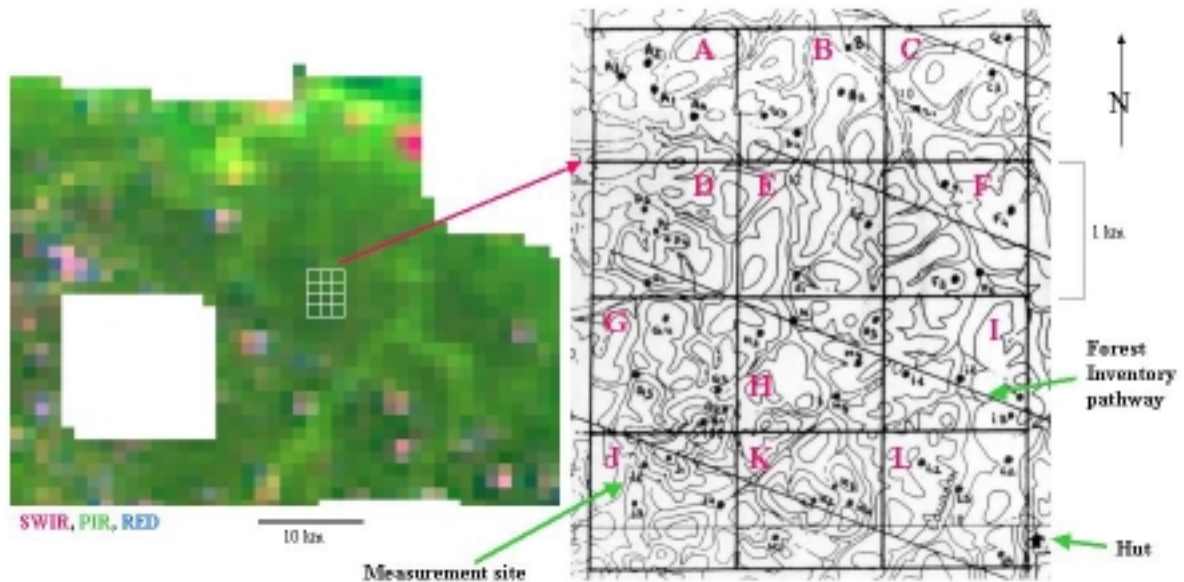


Figure 3 : Measurement sites in the 12 different SPOT-4/VEGETATION pixels. Each measurement was pre-located and definitely chosen in the field depending on the access. Each point was geo-located by GPS.

According to the location of SPOT-4 / VEGETATION data, 12 pixels were delimited on the topographic map (Figure 3). Each pixel was named from A (upper-right corner) to L (bottom-left corner). In each pixel a set of four measurement sites was selected representing four distinct environments identified from the topographic map as (i) thalweg along the waterways, (ii) plateau with their large top tables, (iii) gentle slope ($<20\%$) and (iv) steep slope ($>20\%$). Each of these four environments are characterised by different forest structures. As seen on Figure 3 the pixels were superimposed to a network of forest inventory pathways. This network allows the access to the different parts of the forest. During the field measurements the locations of the chosen sites were adapted to the accessibility.

For each point a geographic position was systematically established (GPS). Then a group of 12 measurements, to be consistent with the VALERI protocol, was made using the fish-eye digital camera. This group is oriented to the North within a square of 20m side. Nine measurements were completed with three randomly distributed measurements inside the square (Figure 4)

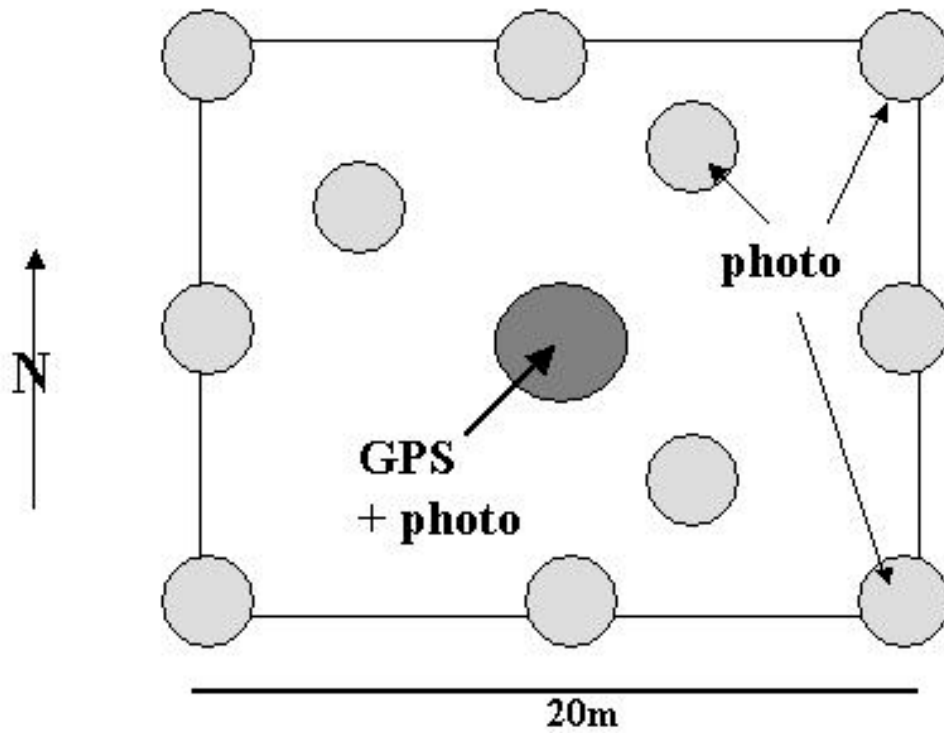


Figure 4 : Fish-eye measurements protocol for each site. Height measurements were made on the sides of a 20m square located around the central point of the measurement site as well as one at this central point. Three randomly choose measurements were also made. All the measurements were oriented with a compass and geo located by GPS.

Results

Fish-eye measurements were carried out on 44 measurement sites representing 528 hemispherical pictures (Figure 5). The two teams made measurements on the same site in order to establish a “calibration point”. Two sets of twenty simultaneous measurements were made along a line starting in a natural area through a deforested area and ending in a natural area again, in order to observe LAI variations linked with human activities. At the end 592 hemispherical pictures were collected.



Figure 5 : Thalweg fish-eye picture in the tropical forest of Counami. Observe Palm tree in the understory and the density of the cover.

Discussion and perspectives

The field campaign was satisfactory because of the good spatial sampling and the amount of data collected. Concerning the Nikon Coolpix 990C, only a battery problem perturbed the measurement in pixel E (only 2 measurement site). A problem also happened in pixel B where the two teams worked simultaneously, and a large part of the pixel's centre was not documented. The use of hemispherical cameras was very convenient because of their weights and easy manipulation. This experiment could not have been accomplished with instruments like LAI-2000 for example. In general the weather was good except several rain showers in the afternoon which disturbed the measurements due to rain drops on the lenses.

About the GPS it could be said that the location was sometimes difficult to obtain due to the density of the vegetation. Three satellites signals were the minimum to get an acceptable precision in the position. The rain has strongly disturbed the GPS measurements. When GPS locations were transferred on the topographic map, a shift in the position was noted. This is due to the different ellipsoids used in these different systems. GPS used the WGS84 and topographic map Clark1880. The shift noted was from 30 to 100m to the North for GPS

location taking the topographic map as a reference. The position transfer on the topographic map was possible with the information noted on the field-cards. It was observed that the Garmin CX12 seems to shift less than the Magellan C815.

The BF2 had several problems with the data logger. This failure was probably due to an electric supplies problem. At the end the data were lost because of a bad manipulation of the battery. No data are available in sun radiation.

The SPOT-HRV image was acquired very late (one month after the field measurements).

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